Abstract of the Disclosure

The method for manufacturing a shallow trench isolation (STI) in a semiconductor device with an enhanced gap-fill property and without a detrimental effect of fluorine by introducing a two-stage thermal process. The method includes steps of: preparing a semiconductor substrate obtained by a predetermined process on which a pad oxide and a pad nitride are formed on predetermined locations thereof; forming a trench structure in the semiconductor substrate; forming a hydrogen (H_2)-based high density plasma (HDP) oxide layer over a first resultant structure; forming a nitrogen trifluoride (NF_3)-based HDP oxide layer into the trench structure with a predetermined depth; carrying out a two-stage thermal process for removing fluorine in the NF_3-based HDP oxide layer; and forming a helium (He)-based HDP oxide layer over a second resultant structure.